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W.P. No. 120-87-00(C)

CONT. No. 90-36

W. O. No.

STR. SITE No.

HWY. No. 416/417

LOCATION Acres Rd., Culvert # 11 (4?)

No. of PAGES -

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

CONT. 90-36

WP 120-87-00C

DIST 9

HWY

STR SITE

Culvert Structure Underneath the Acres Road

Culvert No. 4

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FOUNDATION INVESTIGATION REPORT
For
Culvert Structure Underneath the Acres Road
Culvert No. #4
W.P. 120-87-00C
District 9, Ottawa

INTRODUCTION

This report summarizes the information obtained from a foundation investigation carried out at the above-mentioned site during the period of 89 11 06 to 89 11 07. A 4.0 m span culvert structure is proposed to remove and replace the existing corrugated steel culvert that under passes the existing Acres Road.

Two boreholes (BH #C4-1 and BH #C4-2) were advanced and sampled by means of hollow stem augers with a conventional Cone Penetration Tests. These boreholes extended down to depths of 11.1 to 14.2 metres below the existing ground surface.

This report contains factual information obtained from this investigation together with discussion and recommendations pertaining to structure foundations, approach embankments and related earthworks for the Culvert No. #4 as shown on Drawing No. 1208700C-A.

SITE DESCRIPTION AND GEOLOGY

The proposed structure site is located underneath the existing Acres Road immediately north of the existing Hwy. 417 in the City of Nepean, Ottawa-Carleton Municipality. The topography of the area is generally flat to gently undulating with the land in the immediately vicinity being used for residential purposes. A new municipal pumping station exists west of the site.

Physiographically, the site lies in the area known as the Ottawa Valley Clay Plains founded in the lowlands of the St. Lawrence. The subsoil consists of clay plains interrupted by ridges of rock or sand. Fault scarps are also evident within the area; an illustration of the numerous normal faults that dominate the region. It appears that the site is divided by a fault. The

bedrock in the area is of the March Formation west of the fault, and the Rockcliffe and Gull River Formation east of the fault which are of the middle Ordovician period. The March Formation consists of interbedded quartz sandstone and sandy dolostone, whereas the Rockcliffe and Gull River Formation consists of interbedded fine grained quartz sandstone, silty dolostone, and limestone. The site is transversed by a north-south trending fault which is a geologic structure reportedly common to the area. The overburden was deposited during and immediately following the Wisconsinan glaciation at which time the area was depressed from the effect of the glaciation. Following the retreat of the glacier, the brackish waters of the Champlain Sea flooded the area and then gradually receded as the land rebounded with the deposition of sediments to its present level.

SUBSURFACE CONDITIONS

The subsoil conditions are generally consistent across the site. The surficial layer consists of a generally soft to stiff cohesive silty clay to clayey silt or clayey silt with interbedded sandy silt layers which extends to a maximum thickness of 6.2 m. A deep deposit of silty sand to sand is the subsequent underlying deposit at both BH #C4-1 and BH #C4-2. However, it should be noted that this deposit was not proven for the full depth. The proven thickness down to a depth of 14.2 m below the ground surface is about 5.5 m at BH #C4-2. Within the existing embankment of Acres Road, sand with gravel fill was encountered at both boreholes from the ground surface. The maximum thickness of embankment fill is about 3.5 m at BH #C4-1.

A detailed description of the subsurface conditions encountered is given below.

Silty Clay to Clayey Silt

This stratum was encountered in a borehole (BH #C4-2). This material consists of a silty clay to clayey silt in the thickness of 6.2 m. The material is grey in colour from the intersurface with overlying sand fill.

Two Atterberg Limit tests were performed on these samples and the results are plotted on Figure 1 and summarized as follows:

| <u>Property</u> | <u>Ranges (%)</u> | <u>Average (%)</u> |
|------------------------------|-------------------|--------------------|
| Natural Moisture Content (w) | 34.5-40.0 | 37.3 |
| Liquid Limit (w_L) | 34.5-55.5 | 45.0 |
| Plastic Limit (w_p) | 17.5-20.5 | 19.0 |
| Plasticity Index (I_p) | 17.0-35.0 | 21.0 |

From the plasticity chart, it is evident that the layer can be classified as an inorganic silty clay to clayey silt with intermediate to low plasticity (CI or CL).

Grain size distribution tests were carried out on these materials. Figure 2 in Appendix shows the results.

Undrained shear strength of the soil were determined by in situ vane tests and by laboratory test (unconfined compression test). The results are plotted on the Record of Borehole sheets in the Appendix and summarized as follows:

| <u>Test</u> | <u>Undrained Shear Strength (C_u, kPa)</u> | <u>Sensitivity</u> |
|-----------------------------|---|--------------------|
| Field Vane (2 tests) | 64-96 (Avg. 80 kPa) | 4.6-6.4 |
| Unconfined Compression Test | 68 kPa | |

Recommended shear strength for this deposit can be estimated to be about 80 kPa. Based on this result, the soil has stiff consistency. The sensitivity of the soil is generally moderate to high.

The results (e-log P curves) of a consolidation test on a representative sample is shown on Figure 3. This test indicated that the Clayey Silt has been preconsolidated in the past to an effective pressure of 100 kPa ($P_c - P_o$) in excess of the existing effective overburden pressure. The detail of the result is as follows:

| <u>Parameters</u> | <u>Result</u> |
|---|---------------|
| Preconsolidation pressure, P_c (kPa) | 240 |
| Initial Void Ratio (e_0) | 0.997 |
| Compression Index (C_c) | 0.448 |

Clayey Silt with Interbedded Sandy Silt

Underlying the surficial deposit of road way sand with gravel fill, a layer of grey clayey silt with interbedded sandy silt was encountered at BH #C4-1. This stratum extends to depth of 6.1 m below the ground surface and was found within silty sand deposit at BH #C4-2. The thickness of the stratum was found to be about 2.6 m at BH #C4-1.

The results from the 2 Atterberg Limit tests performed on this material are summarized as follows:

| <u>Property</u> | <u>Ranges (%)</u> | <u>Average (%)</u> |
|------------------------------|-------------------|--------------------|
| Natural Moisture Content (w) | 32.0-35.5 | 33.8 |
| Liquid Limit (w_L) | 21.0-28.5 | 24.8 |
| Plastic Limit (w_p) | 12.0-13.5 | 12.8 |
| Plasticity Index (I_p) | 9.0-15.0 | 12.0 |

From the plasticity chart (Figure 4), it is evident that the layer can be classified as an inorganic clayey silt with interbedded sandy silt with low plasticity (CL or CL-ML).

Grain size distribution tests were carried out on these materials. Figure 5 in the Appendix shows the results.

Undrained shear strength of the soil was determined by in situ vane tests. The results are plotted on the Record of Borehole sheets in the Appendix and summarized as follows:

| <u>Undrained Shear Strength</u> | <u>kPa</u> | <u>Average (kPa)</u> | <u>Sensitivity</u> |
|---------------------------------|------------|----------------------|--------------------|
| Field Vane (2 tests) | 52-76 | 64 | 23-3.7 |

Due to the irregular nature of the deposit, that reveals numerous seams and layers of sandy silt interbedded within the clayey silt, the results provided in the above table are not necessarily indicative of the shear strength of the clayey silt portion. In view of this consideration, the consistency of the clayey silt portion can be described as firm to stiff. The sandy silt portion was generally very loose in denseness. For design purposes, an undrained shear strength of 65 kPa can be assumed for this stratum.

Silty Sand

This deposit was encountered below silty clay to clayey silt layer or the clayey silt with interbedded sandy silt layer. The proven thickness of this layer ranges from 5.0 m at BH #C4-1 to 5.5 m at BH #C4-2.

This deposit contains a minor variation in gravel content and irregular layer of clayey silt throughout its thickness. Generally, the deposit contains trace of gravel, but at some locations, considerable gravel was encountered. Grain size distribution curves indicate that the soil can be classified to a silty sand to sand. This layer is basically non-plastic. Figure 6 in the Appendix shows the result of Grain Size Distribution test.

In this stratum, the 'N' values ranged from 5 to 21 blows/0.3 m indicating a state of compaction described as loose to compact. However, at certain locations low resistance (1 blow/0.3 m) encountered. This may be attributed to 'boiling' of subsoil due to unbalanced hydrostatic head and consequently do not represent the undisturbed denseness of the soil.

GROUNDWATER CONDITIONS

Observation of the groundwater level was carried out by measuring the water level in the open boreholes and a piezometer installed in BH #C4-1. Groundwater levels in the boreholes were found to range between elevation 60.6 m at BH #C4-1 and elevation 58.5 m at BH #C4-2. This corresponds to depths of 4.5 m to 9.6 m below the existing ground surface.

DISCUSSION AND RECOMMENDATIONS

The recommendations in this report apply to the concrete culvert and related approaches.

It is proposed to move and replace the existing corrugate steel culvert with a 4.0 m span concrete culvert underneath the existing Acres Road at the base elevation of about 60.1 m (approximately 8 m below the existing Acres Road) immediately north of Hwy. 417. The proposed culvert will be a 4.0 m x 2.0 m box culvert with an appropriate length of about 84.0 m. Approximately 6 m fill will be placed over the proposed concrete culvert.

Based on the site investigation, the foundation recommendations for the design of concrete box culvert are as follows:

STRUCTURE FOUNDATION FOR CONCRETE CULVERTS

The proposed concrete culvert structure may be founded on spread footings located within the native clayey silt layer at the southwestern portion of culvert and the native silty clay to clayey silt layer at the northeastern portion of culvert that predominate the site. For purposes of the O.H.B.D.C., the following design values are recommended at the invert elevation of culvert provided:

| Structure | Bearing Capacity at S.L.S. Type II (kPa) | Factored Bearing Capacity at U.L.S. (kPa) | Recommended Footing Elev. (m) |
|------------------|--|---|----------------------------------|
| Concrete Culvert | 150 | 300 | 60.1-60.4 |

A footing width of 4.0 m was used in the calculation of the capacities.

To protect the footings against scour, a properly designed rip-rap meeting the filter design criteria and hydrological requirements at site, should be placed at the culvert channel inlet and outlet.

Settlement of the foundation subsoil as a result of the applied footing pressure will be negligible since no additional embankment loads is applied on the concrete culvert. However, it should be noted that the subsoil be not disturbed

by construction or related activities. It is recommended that a working slab be placed to protect the footing founding soil within 4 hours of exposure.

Resistance to sliding of the footings can be calculated assuming an adhesion of 75 kPa to apply between the underside of the concrete culvert and the founding soil in accordance with Section 6.6.1.2.1 of the O.H.B.D.C.

OTHER CONSIDERATIONS

Lateral Earth Pressures on Culvert Walls

Free draining material such as Granular 'A' or Granular 'B' is recommended as appropriate backfill to the culvert walls to prevent hydrostatic pressure build-up.

Design parameters of the soil are given below for purpose of the O.H.B.D.C.:

| | <u>Granular 'A'</u> | <u>Granular 'B'</u> |
|--|---------------------|---------------------|
| Angle of Internal Friction (ϕ) | 35° | 30° |
| Unit Weight (kN/m ³) | 22.8 | 21.2 |
| Coefficient of Earth Pressure at Rest (K_0)* | 0.43 | 0.50 |

*for horizontal backfill only.

The earth pressure coefficient at rest is to be used in design if culvert structure is rigid and unyielding. Weep holes in the culvert walls should be designed to drain any accumulation of water in the backfill.

Dewatering

No major dewatering difficulties are anticipated for footing excavations in consideration of the relatively low permeability of the cohesive foundation soils. However, if localized seepage or surface water do accumulate in excavations, it can be controlled by perimeter ditches and pumping from sumps.

Frost Protection

The footings should be placed so as to have a minimum earth cover or 1.8 m to allow for frost protection.

Approach Fills

No stability problems are anticipated for the proposed height of permanent embankment constructed to a 2H:1V geometry.

Cut Slopes at Culvert Inlet and Outlet, and Drainage Channel

The critical condition for stability of the open cut slopes proposed at the culvert inlet and outlet, and drainage channel will be the long term condition and consequently an effective stress analysis was implemented incorporating a minimum factor of safety of 1.3.

Based on the analyses, the following conclusions have been derived:

- 1) Excavation down to 5.0 metres in depth will be stable provided they are maintained with 2H:1V slope, while deeper cuts to 7 metres will require a flatter slope of $2\frac{1}{2}$ H:1V.

CONSTRUCTION CONSIDERATIONS

- 1) Temporary excavation cuts for foundation elements should be at slopes no steeper than 2H:1V in view of the high water table.
- 2) In order to get a gravitational drainage system in the vicinity of the culvert excavation, it is recommended that the construction of drainage channel downstream of the Culvert #4 should be implemented prior to excavation for the culvert foundation.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Tae C. Kim, Foundation Design Engineer, and Dale Colquhoun, visiting Engineer from Jamaica. The equipment was owned and operated by Marathon Drilling Co. and Johnston Drilling Co., Ottawa.

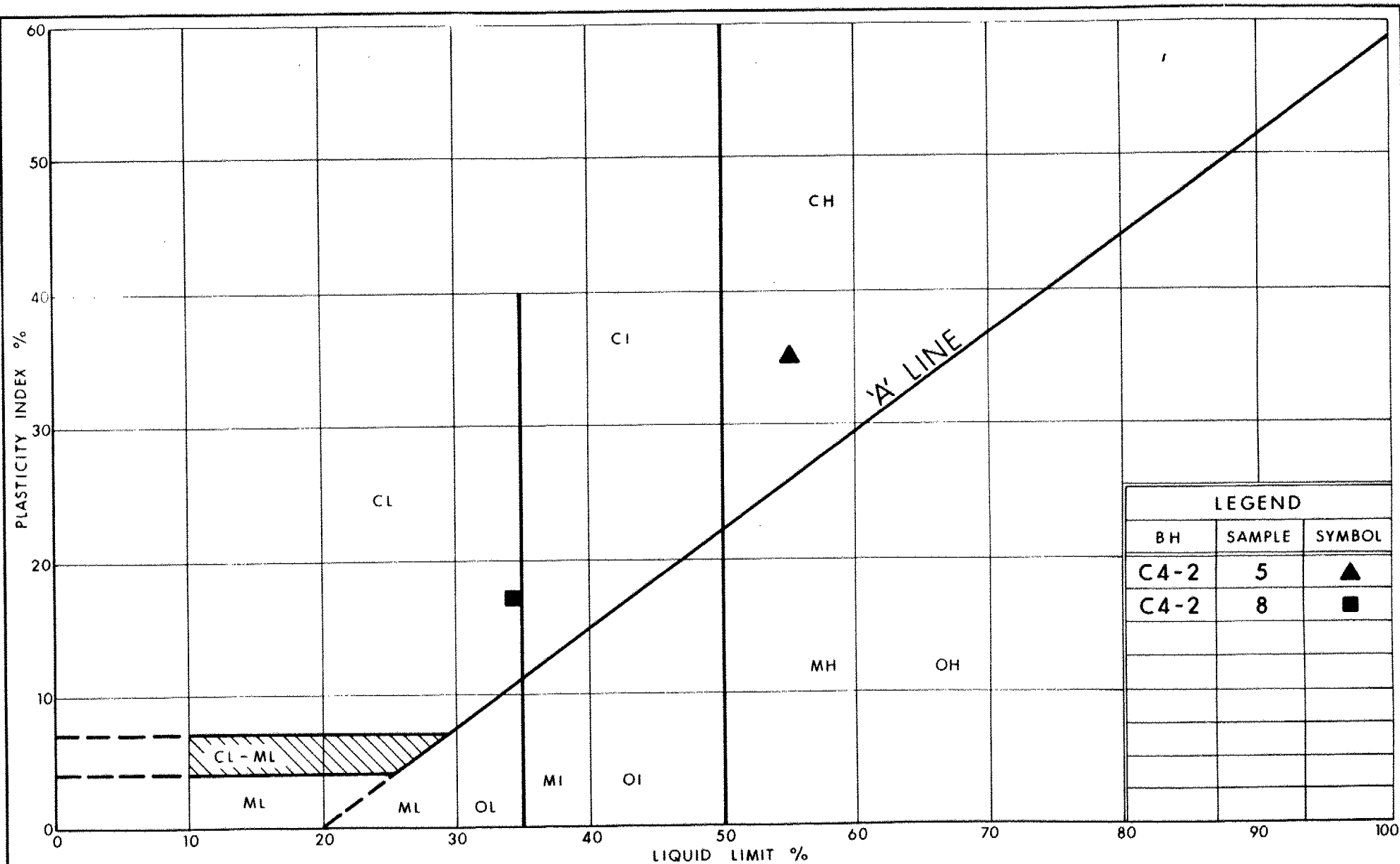
The project was carried out by Tae C. Kim under the general supervision of Dr. B. Iyer. This report was written by Tae C. Kim, Foundation Design Engineer, reviewed by Dr. B. Iyer, Sr. Foundation Engineer and approved by M. Devata, Chief Foundation Engineer.



Tae C. Kim
Tae C. Kim, P.Eng.
Foundation Design Engineer

M. Devata
M. Devata, P.Eng.
Chief Foundation Engineer

APPENDIX



Ontario

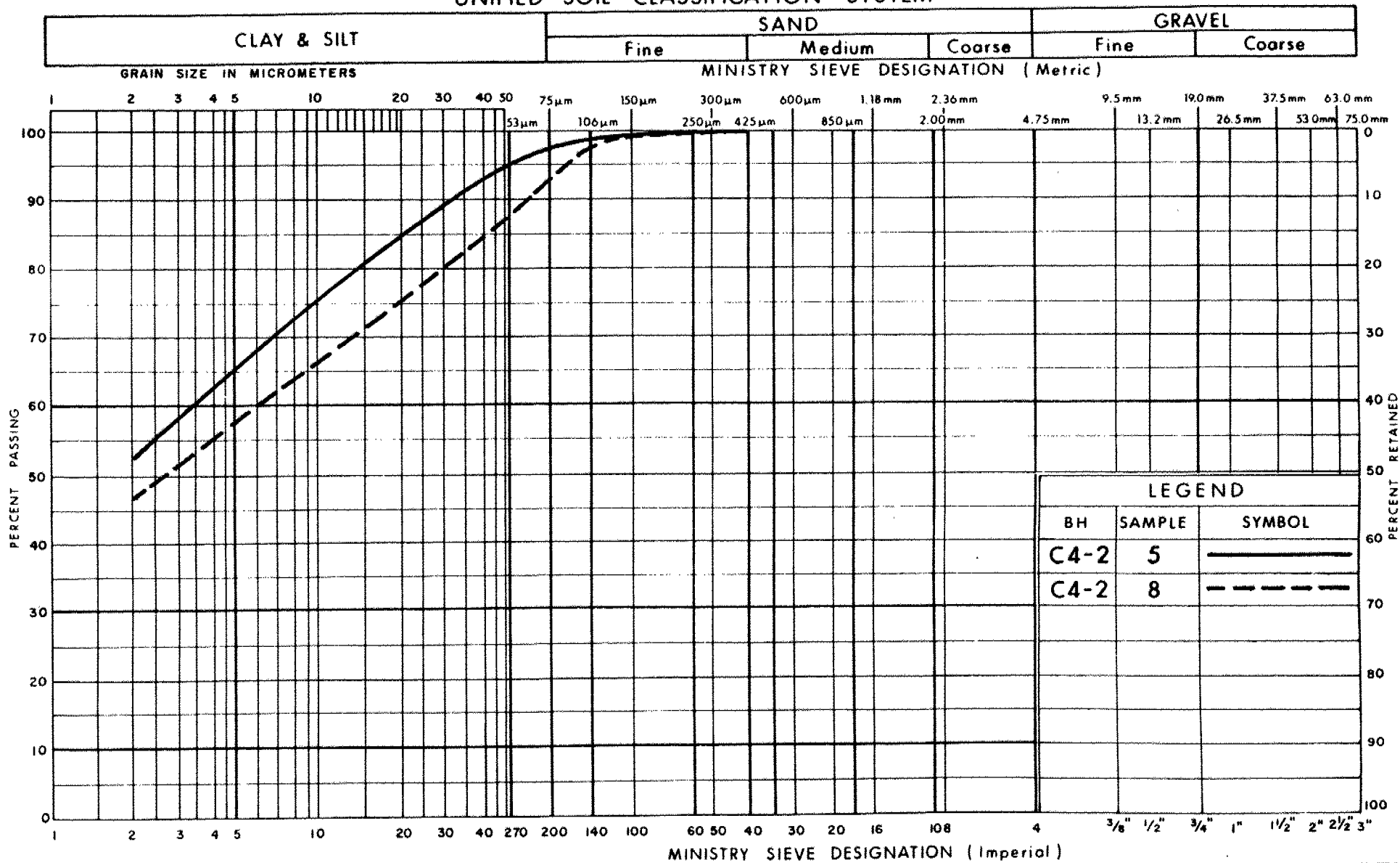
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PLASTICITY CHART SILTY CLAY TO CLAYEY SILT

FIG No 1

W P 120-87-00C

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

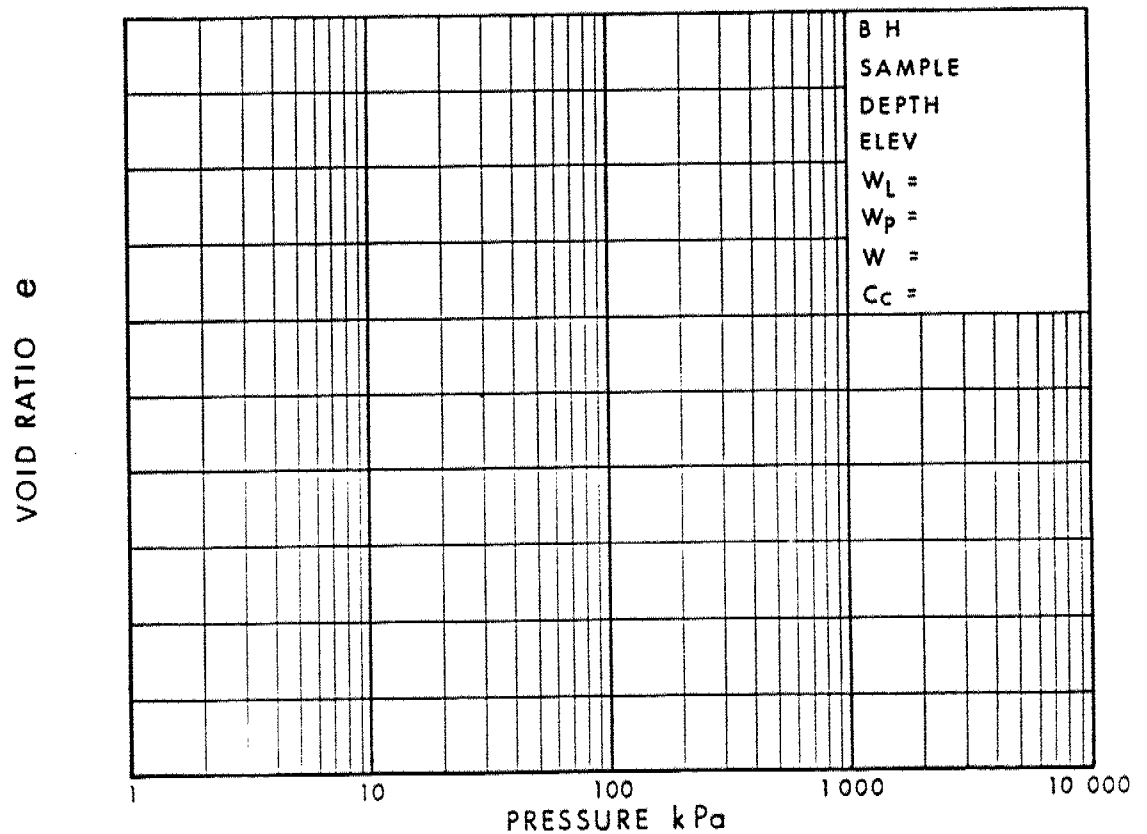
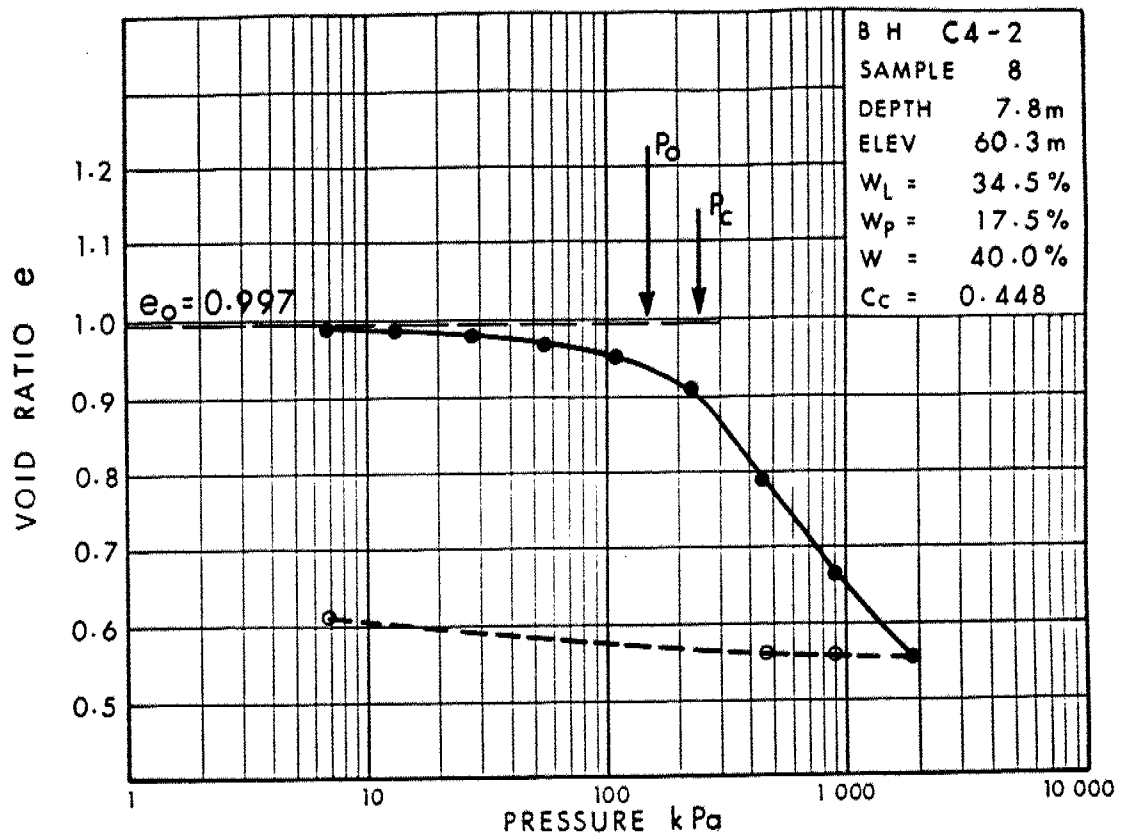
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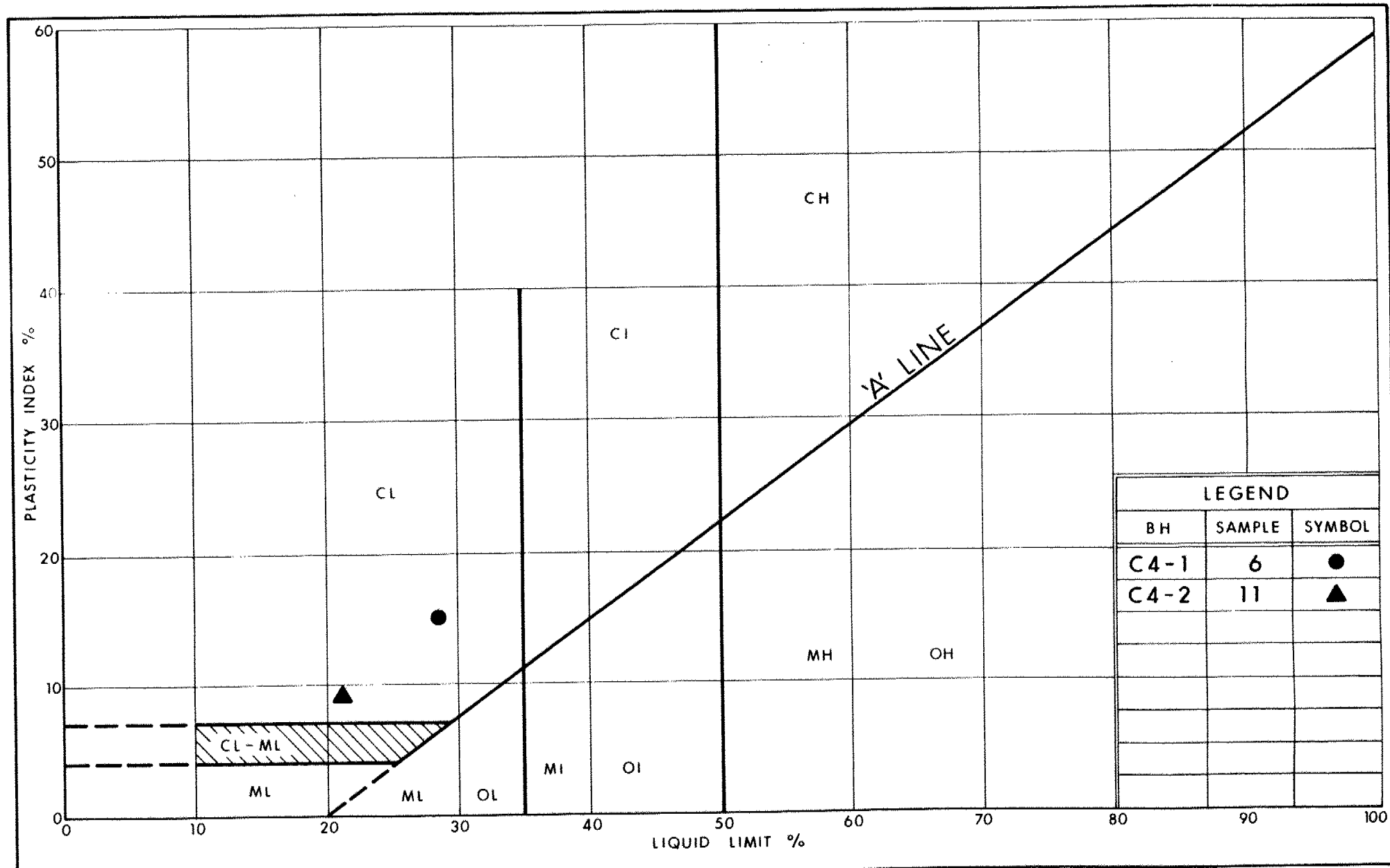
GRAIN SIZE DISTRIBUTION
SILTY CLAY TO CLAYEY SILT

FIG No 2

W P 120-87-00 C

VOID RATIO - PRESSURE CURVES





Ontario

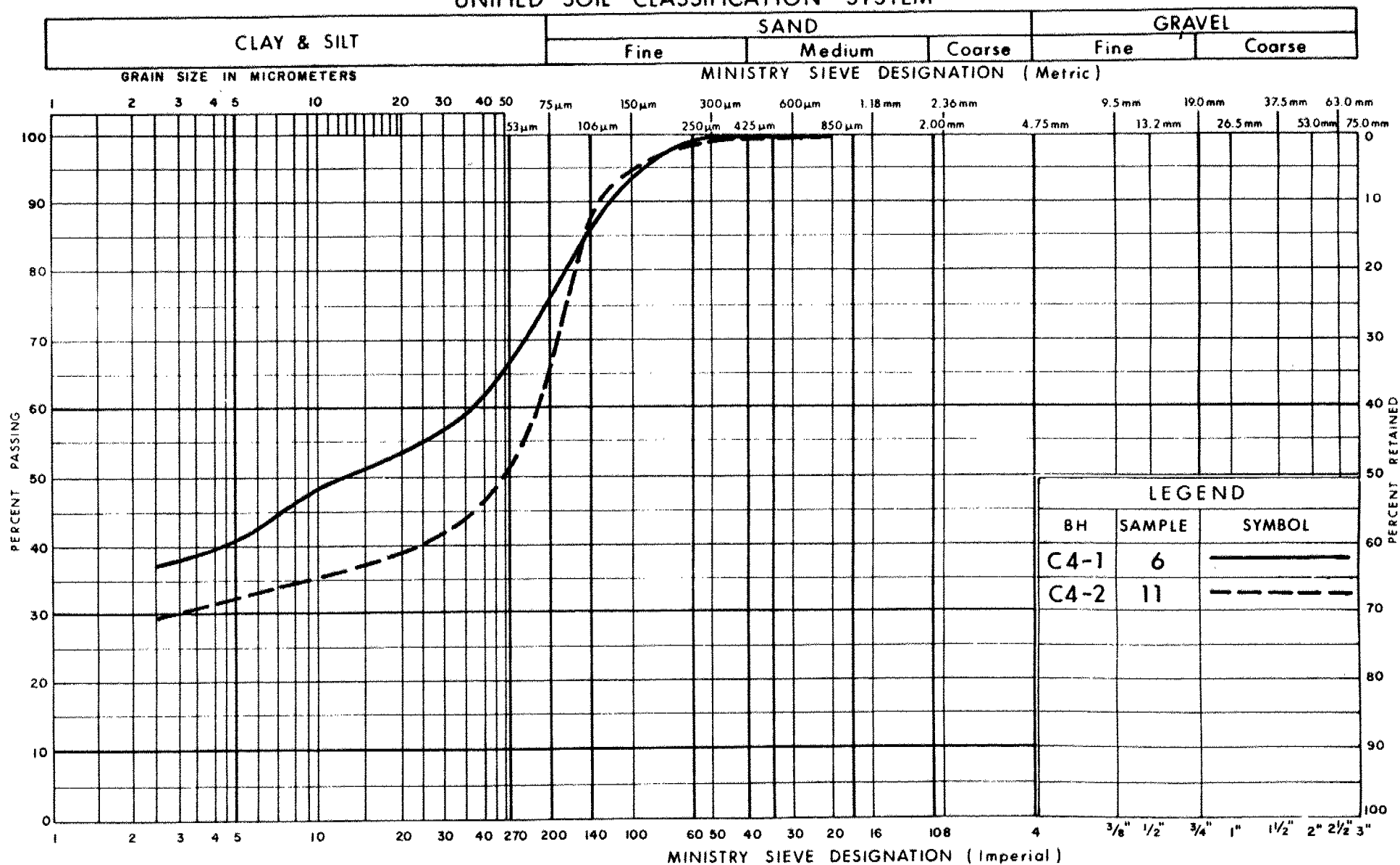
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PLASTICITY CHART CLAYEY SILT WITH INTERBEDDED SANDY SILT

FIG No 4

W P 120-87-00 C

UNIFIED SOIL CLASSIFICATION SYSTEM



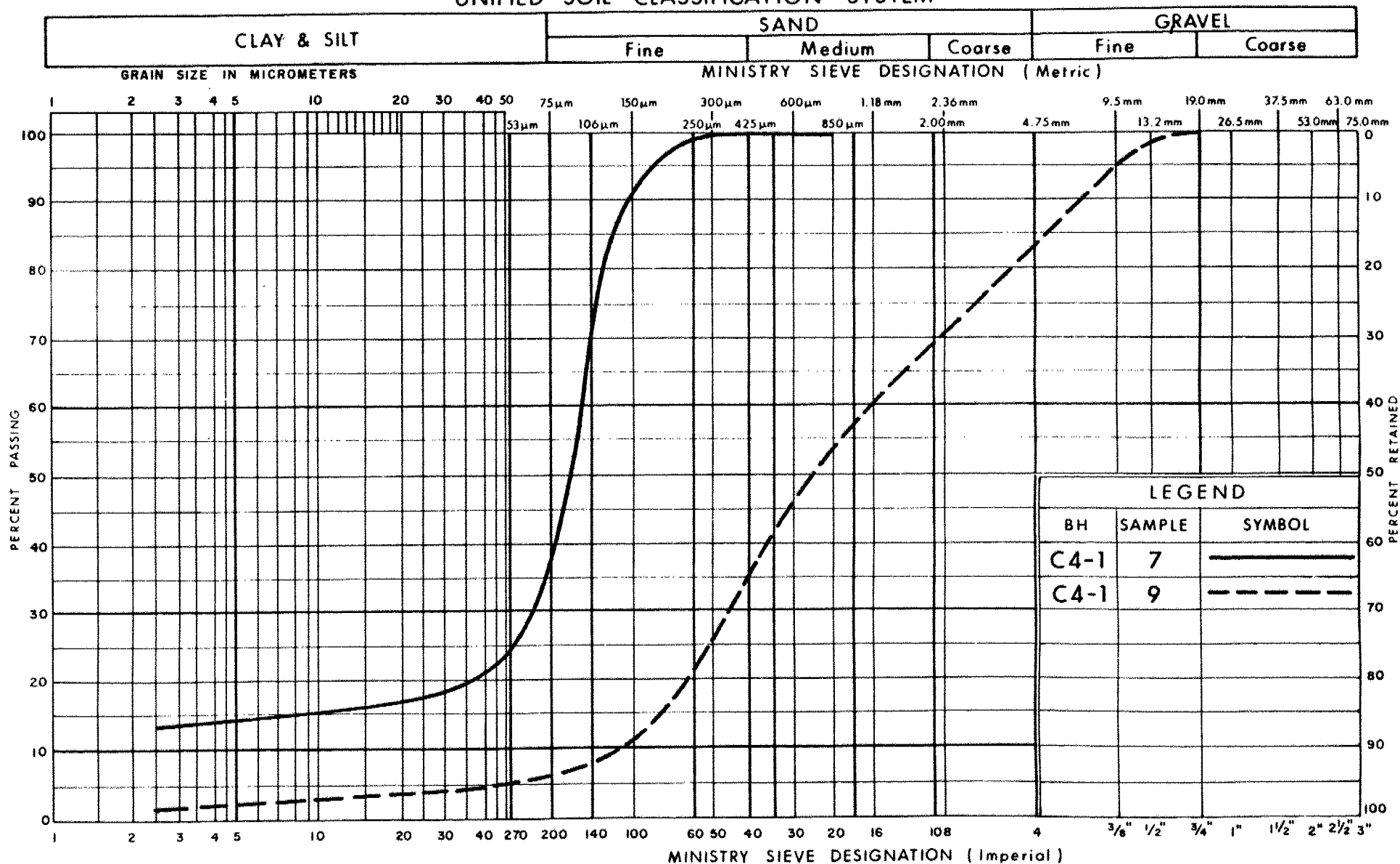
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GRAIN SIZE DISTRIBUTION
CLAYEY SILT WITH INTERBEDDED SANDY SILT

FIG No 5

W P 120-87-00C

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION
SILTY SAND TO SAND TRACE TO SOME GRAVEL

FIG No 6

W P 120-87-00 C

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O D SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O D 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 1" SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

| c_u (kPa) | 0 - 12 | 12 - 25 | 25 - 50 | 50 - 100 | 100 - 200 | > 200 |
|-------------|-----------|---------|---------|----------|------------|-------|
| | VERY SOFT | SOFT | FIRM | STIFF | VERY STIFF | HARD |

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

| N (BLOWS/0.3m) | 0 - 5 | 5 - 10 | 10 - 30 | 30 - 50 | > 50 |
|----------------|------------|--------|---------|---------|------------|
| | VERY LOOSE | LOOSE | COMPACT | DENSE | VERY DENSE |

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

| RQD (%) | 0 - 25 | 25 - 50 | 50 - 75 | 75 - 90 | 90 - 100 |
|---------|-----------|---------|---------|---------|-----------|
| | VERY POOR | POOR | FAIR | GOOD | EXCELLENT |

JOINTING AND BEDDING:

| SPACING | 50mm | 50 - 300mm | 0.3m - 1m | 1m - 3m | > 3m |
|----------|------------|------------|------------|---------|------------|
| JOINTING | VERY CLOSE | CLOSE | MOD. CLOSE | WIDE | VERY WIDE |
| BEDDING | VERY THIN | THIN | MEDIUM | THICK | VERY THICK |

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

| | | | |
|-----|---------------------|-----|----------------------------|
| S S | SPLIT SPOON | T P | THINWALL PISTON |
| W S | WASH SAMPLE | O S | OSTERBERG SAMPLE |
| S T | SLOTTED TUBE SAMPLE | R C | ROCK CORE |
| B S | BLOCK SAMPLE | P H | T W ADVANCED HYDRAULICALLY |
| C S | CHUNK SAMPLE | P M | T W ADVANCED MANUALLY |
| T W | THINWALL OPEN | F S | FOIL SAMPLE |

STRESS AND STRAIN

| | | |
|--------------------------------------|-----|-------------------------------|
| u_w | kPa | PORE WATER PRESSURE |
| r_u | 1 | PORE PRESSURE RATIO |
| σ | kPa | TOTAL NORMAL STRESS |
| σ' | kPa | EFFECTIVE NORMAL STRESS |
| τ | kPa | SHEAR STRESS |
| $\sigma_1, \sigma_2, \sigma_3$ | kPa | PRINCIPAL STRESSES |
| ϵ | % | LINEAR STRAIN |
| $\epsilon_1, \epsilon_2, \epsilon_3$ | % | PRINCIPAL STRAINS |
| E | kPa | MODULUS OF LINEAR DEFORMATION |
| G | kPa | MODULUS OF SHEAR DEFORMATION |
| μ | 1 | COEFFICIENT OF FRICTION |

MECHANICAL PROPERTIES OF SOIL

| | | |
|----------------|-------------------|--------------------------------------|
| m_v | kPa ⁻¹ | COEFFICIENT OF VOLUME CHANGE |
| C_c | 1 | COMPRESSION INDEX |
| C_s | 1 | SWELLING INDEX |
| C_α | 1 | RATE OF SECONDARY CONSOLIDATION |
| c_v | m ² /s | COEFFICIENT OF CONSOLIDATION |
| H | m | DRAINAGE PATH |
| T_v | 1 | TIME FACTOR |
| U | % | DEGREE OF CONSOLIDATION |
| σ'_{VO} | kPa | EFFECTIVE OVERBURDEN PRESSURE |
| σ'_p | kPa | PRECONSOLIDATION PRESSURE |
| τ_f | kPa | SHEAR STRENGTH |
| c' | kPa | EFFECTIVE COHESION INTERCEPT |
| ϕ' | -° | EFFECTIVE ANGLE OF INTERNAL FRICTION |
| c_u | kPa | APPARENT COHESION INTERCEPT |
| ϕ_u | -° | APPARENT ANGLE OF INTERNAL FRICTION |
| τ_R | kPa | RESIDUAL SHEAR STRENGTH |
| τ_r | kPa | REMOULDED SHEAR STRENGTH |
| S_t | 1 | SENSITIVITY = $\frac{c_u}{\tau_r}$ |

PHYSICAL PROPERTIES OF SOIL

| | | | | | | | | |
|----------------|-------------------|--------------------------------|-----------|------|---|-----------|-------------------|---|
| ρ_s | kg/m ³ | DENSITY OF SOLID PARTICLES | e | 1, % | VOID RATIO | e_{min} | 1, % | VOID RATIO IN DENSEST STATE |
| γ_s | kn/m ³ | UNIT WEIGHT OF SOLID PARTICLES | n | 1, % | POROSITY | I_D | 1 | DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$ |
| ρ_w | kg/m ³ | DENSITY OF WATER | w | 1, % | WATER CONTENT | D | mm | GRAIN DIAMETER |
| γ_w | kn/m ³ | UNIT WEIGHT OF WATER | s_r | % | DEGREE OF SATURATION | D_n | mm | n PERCENT - DIAMETER |
| ρ | kg/m ³ | DENSITY OF SOIL | w_L | % | LIQUID LIMIT | C_u | 1 | UNIFORMITY COEFFICIENT |
| γ | kn/m ³ | UNIT WEIGHT OF SOIL | w_p | % | PLASTIC LIMIT | h | m | HYDRAULIC HEAD OR POTENTIAL |
| ρ_d | kg/m ³ | DENSITY OF DRY SOIL | w_L | % | SHRINKAGE LIMIT | q | m ³ /s | RATE OF DISCHARGE |
| γ_d | kn/m ³ | UNIT WEIGHT OF DRY SOIL | i | % | PLASTICITY INDEX = $w_L - w_p$ | v | m/s | DISCHARGE VELOCITY |
| ρ_{sat} | kg/m ³ | DENSITY OF SATURATED SOIL | | 1 | LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$ | i | 1 | HYDRAULIC GRADIENT |
| γ_{sat} | kn/m ³ | UNIT WEIGHT OF SATURATED SOIL | | 1 | CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$ | k | m/s | HYDRAULIC CONDUCTIVITY |
| ρ' | kg/m ³ | DENSITY OF SUBMERGED SOIL | e_{max} | 1, % | VOID RATIO IN LOOSEST STATE | j | kn/m ³ | SEEPAGE FORCE |
| γ' | kn/m ³ | UNIT WEIGHT OF SUBMERGED SOIL | | | | | | |



RECORD OF BOREHOLE No C4-1

METRIC

W P 120-87-00C LOCATION Co-ords: N 5 022 935.8; E 358 381.0 ORIGINATED BY DC
DIST 9 HWY 416/417 BOREHOLE TYPE H.S. Auger and Cone Test COMPILED BY TCK
DATUM Geodetic DATE 89 11 06 and 07 CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION

| SOIL PROFILE | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT Y | REMARKS & GRAIN SIZE DISTRIBUTION (%) | |
|---------------|---|------------|--------|------|----------------------------|--------------------|---|-----------------|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|-----------------|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | | | VALUES | 20 40 60 80 100 | | | | | | 20 40 60 80 100 |
| 65.1 | Ground Surface | | | | | | | | | | | | GR SA SI CL | |
| 0.0 | Sand and Gravel (Fill) | | 1 | SS | 11 | | | | | | | | 11 79 9 1 | |
| | | | 2 | SS | 5 | | | | | | | | | |
| | | | 3 | SS | 3 | | | | | | | | | |
| | | | 4 | SS | 5 | | | | | | | | | |
| 61.6 | Brown Clayey Silt With Interbedded Sandy Silt Layers (Stiff) | | 5 | SS | 7 | | | | | | | | 0 24 37 39 | |
| 3.5 | | | 6 | SS | 1 | | | | | | | | | |
| 59.0 | Silty Sand to Sand Trace to Some Gravel Loose to Compact | | 7 | TN | PH | | | | | | | | 0 58 27 15 | |
| 6.1 | | | 8 | SS | 15 | | | | | | | | | |
| | | | 9 | SS | 21 | | | | | | | | | |
| | | | 10 | SS | 20 | | | | | | | | | |
| 54.0 | End of Borehole | | | | | | | | | | | | | |
| 11.1 | | | | | | | | | | | | | | |
| 52.0 | | | | | | | | | | | | | | |
| 12.2 | End of Cone Test | | | | | | | | | | | | | |
| | <u>Piezometer Installation</u> P-1 (Tip at 5.3m BGS) 0 - 4.6m Backfill 4.66 - 4.84m Bentonite Seal 4.84 - 5.03m Backfill 5.03 - 5.64m Pea Gravel 5.64 - 5.79m Bentonite Seal 5.79 - 6.10m Pea Gravel 6.10 - 11.10m Backfill | | | | | | | | | | | | | |

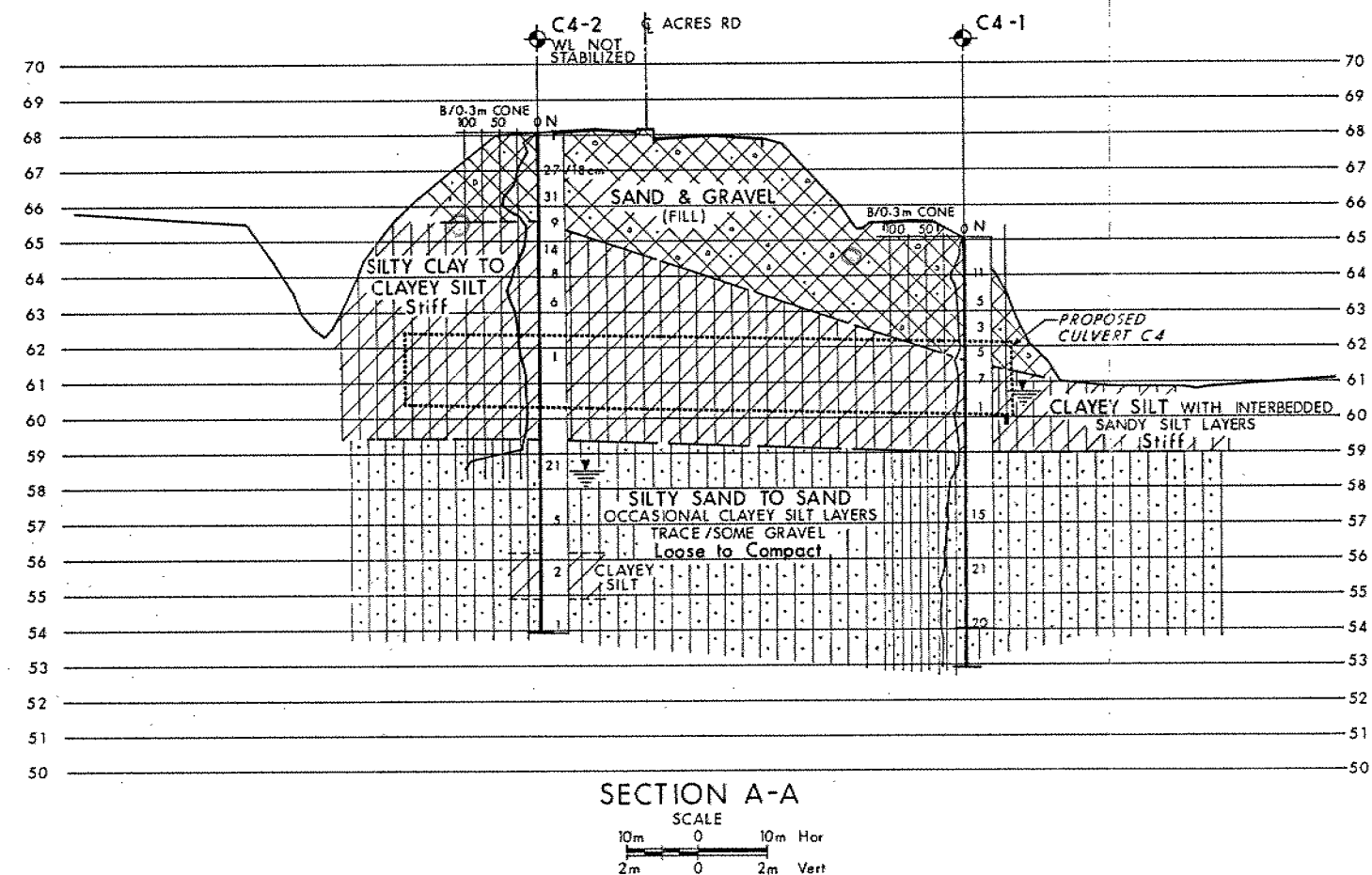
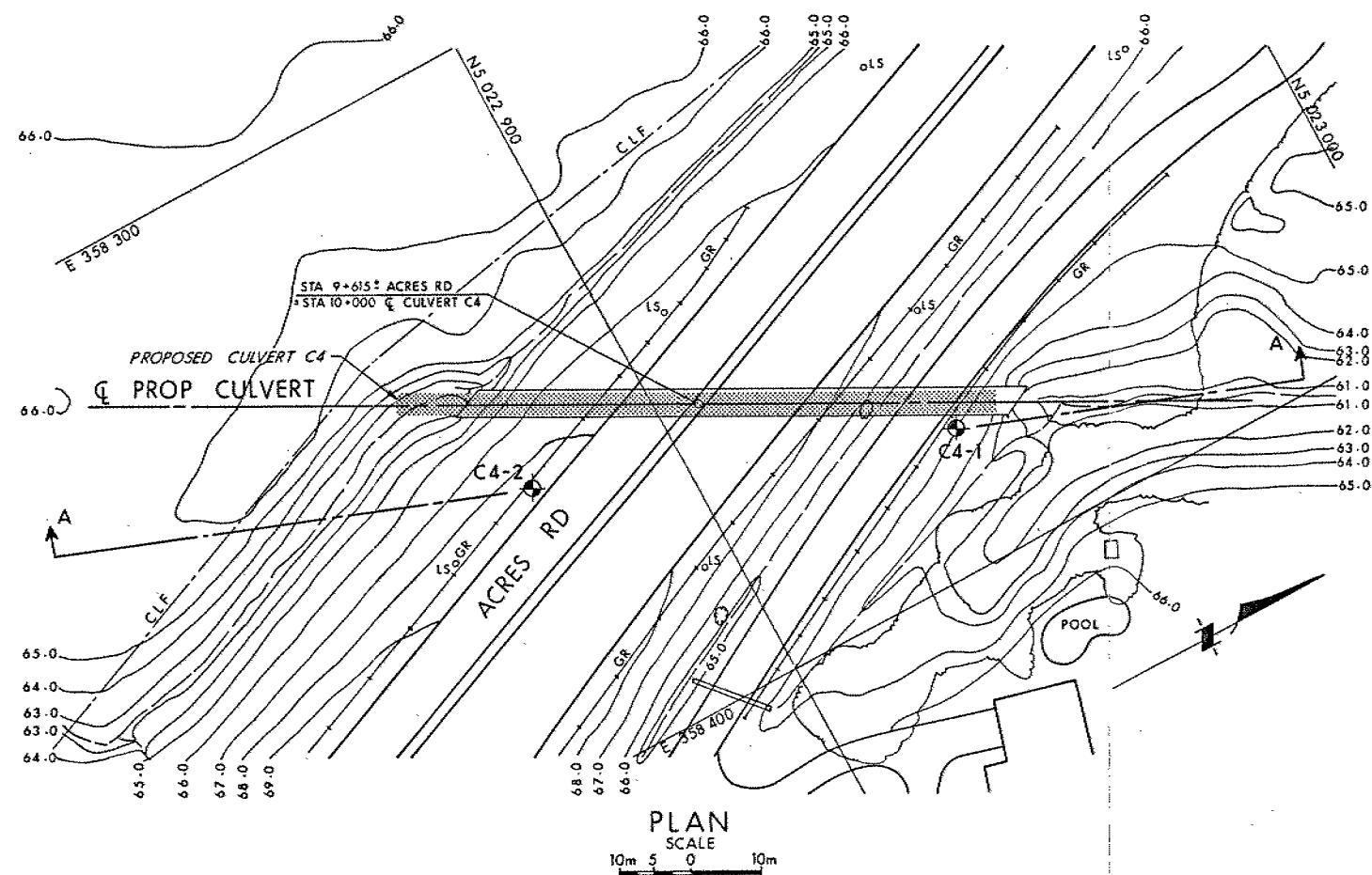
RECORD OF BOREHOLE No C4-2

METRIC

W P 120-87-00C LOCATION Co-ords: N 5 022 879.6; E 358 360.3 ORIGINATED BY DC
 DIST 9 HWY 416/417 BOREHOLE TYPE H.S. Auger and Cone Test COMPILED BY TCK
 DATUM Geodetic DATE 89 11 06 and 07 CHECKED BY TCK

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT Y | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 68.1 | Ground Surface | | | | | | | | | | | | | | | | GR SA SI CL |
| 0.0 | Sand and Gravel (Fill) | | 1 | SS | 27 | 18cm | 68 | | | | | | | | | | |
| 65.6 | | Brown | 2 | SS | 31 | | 66 | | | | | | | | | | |
| 2.5 | | Grey | 3 | SS | 9 | | | | | | | | | | | | |
| | Silty Clay to Clayey Silt | | 4 | SS | 14 | | 64 | | | | | | | | | | 0 2 45 53 |
| | Stiff | | 5 | SS | 8 | | | | | | | | | | | | |
| | | | 6 | SS | 6 | | 62 | | | | | | | | | | |
| | | | 7 | SS | 1 | | 60 | | | | | | | | | | |
| 59.4 | | | 8 | TK | PM | | | | | | | | | | | | |
| 8.7 | Silty Sand to Sand Occasional Clayey Silt Layers Loose to Compact | | 9 | SS | 21 | | 58 | | | | | | | | | | 0 8 46 46 |
| | | | 10 | SS | 5 | | 56 | | | | | | | | | | |
| | Clayey Silt | | 11 | SS | 2 | | | | | | | | | | | | 0 37 35 28 |
| 53.9 | | | 12 | SS | 1 | | 54 | | | | | | | | | | |
| 14.2 | End of Borehole | | | | | | | | | | | | | | | | |
| | *Water Level not Stabilized | | | | | | | | | | | | | | | | |

OFFICE REPORT ON SOIL EXPLORATION



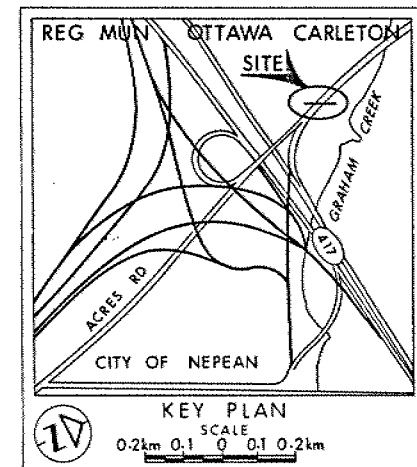
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 120-87-00C

ACRES RD
CULVERT No 4
BORE HOLE LOCATIONS & SOIL STRATA



SHEET



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊗ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- WL at time of investigation. 89 11
- WL in Piezometer
- Piezometer

| No | ELEVATION | CO-ORDINATES NORTH | EAST |
|------|-----------|-----------------------|-----------|
| C4-1 | 65.1 | 5 022 935.8 | 358 381.0 |
| C4-2 | 68.1 | 5 022 879.6 | 358 360.3 |

NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

| REV. | DATE | BY | DESCRIPTION |
|------|------|----|-------------|
| 1 | 89 | | |

Geocres No 31G5-174

| | |
|----------------------------------|----------------|
| HWY No 416/417 | DIST 9 |
| SLBMOTCK (CHECKED) DATE 90 02 19 | SITE |
| DRAWN: DT (CHECKED) APPROVED | DWG 1208700C-A |